

# Assessment of Direct and Indirect GHG Emissions Associated with Petroleum Fuels

## Study Overview

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# Study Objectives

- Identify direct and indirect emissions associated with petroleum fuels
- Estimate emissions that are not included in traditional LCAs
- Categorize emissions as direct and indirect
- Provide recommendations for further analysis

# Petroleum Production Impacts

- Facility construction
- Oil exploration
- Oil production
- Oil refining
- Transport
- Vehicle

- Heavy oil
- Forest clearing
- Forest roads
- Residual oil
- Petroleum coke
- Protection of oil supply
- Venting and flaring



# Emissions included in LCA studies

- Included in traditional fuel life cycle analysis
- Excluded from traditional fuel life cycle analysis because relative difference among fuels is small
- ⦿ Not included in traditional full fuel life cycle analyses
- ⊙ Include in traditional fuel life cycle analyses and needs much work
  - Not applicable

# Petroleum Infrastructure

- Oil production and refining
  - Several studies looking at oil sands and conventional oil production and refining
- Land Use Conversion
  - Several studies looking at direct LUC
  - Road indirect LUC? Priced induced LUC?
- Fate of residual oil and petroleum coke
  - Bunker fuel for marine transport – price effect
  - Transportation logistics
  - Market substitution in power sector
  - Considered in PwC GtL GHG study
  - Requires economic modeling

# Other Petroleum Effects

- Economic impacts
  - Effect of prices
  - GHGs be integrated into global CGE studies
  - Requires more detailed petroleum sectors
- Military activity
  - Hard to agree on approach
  - What is direct
  - Indirect
  - Economic effects are often cited

| Petroleum Supply Option | Direct Effects  |                |                         |              |           |                     |                                |              |                       |                 | Indirect Effects     |                        |                          |                     |                   |
|-------------------------|-----------------|----------------|-------------------------|--------------|-----------|---------------------|--------------------------------|--------------|-----------------------|-----------------|----------------------|------------------------|--------------------------|---------------------|-------------------|
|                         | Oil Exploration | Oil Production | Methane losses, flaring | Oil Refining | Transport | Land Use Conversion | Tailing lakes, CH <sub>4</sub> | Vehicle fuel | Exhaust minor species | Material inputs | Refinery Co-products | Macro Economic Effects | Protection of oil supply | Iraq Reconstruction | Indirect land Use |
| Venezuelan Heavy        | ⊙               | ⊙              | ⊙                       | ⊙            | ⊙         | ⊙                   | ⊖                              | ●            | ●                     | ○               | ⊙                    | ⊙                      | ⊙                        | ⊙                   | ⊙                 |
| Canadian Oil Sands      | ⊙               | ⊙              | ⊙                       | ⊙            | ⊙         | ⊙                   | ⊙                              | ●            | ●                     | ⊙               | ⊙                    | ⊙                      | ⊖                        | ⊙                   | ⊖                 |
| Iraqi                   | ⊙               | ⊙              | ⊙                       | ⊙            | ⊙         | ⊖                   | ⊖                              | ●            | ●                     | ○               | ⊙                    | ⊙                      | ⊙                        | ⊖                   | ⊖                 |
| Nigerian                | ⊙               | ⊙              | ⊙                       | ⊙            | ⊙         | ⊖                   | ⊖                              | ●            | ●                     | ○               | ⊙                    | ⊙                      | ⊖                        | ⊖                   | ⊖                 |
| California TEOR         | ⊙               | ⊙              | ⊙                       | ⊙            | ⊙         | ⊙                   | ⊖                              | ●            | ●                     | ○               | ⊙                    | ⊙                      | ⊖                        | ⊙                   | ⊖                 |
| U.S. Off Shore          | ⊙               | ⊙              | ⊙                       | ⊙            | ⊙         | ⊖                   | ⊖                              | ●            | ●                     | ⊙               | ⊙                    | ⊙                      | ⊖                        | ⊖                   | ⊖                 |
| Conventional            | ⊙               | ●              | ●                       | ⊙            | ⊙         | ⊙                   | ⊖                              | ●            | ●                     | ○               | ⊙                    | ⊙                      | ⊖                        | ⊖                   | ⊖                 |

# Life Cycle GHG Emissions for Gasoline

Direct +  
Indirect

Vehicle +  
Fuel Cycle

